International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN (P): 2249-6890; ISSN (E): 2249-8001
Vol. 8, Issue 2, Apr 2018, 1059-1064

EXPERIMENTAL INVESTIGATION OF THE PERFORMANCE OF INTERNAL COMBUSTION ENGINE BY WATER/METHANOL INJECTION

VELAVAN. R & VIGNESH. C

Assistant Professor, Mechanical Engineering, M. Kumarasamy College of Engineering, Karur, Tamil Nadu India

ABSTRACT

This project deals with the development and testing of IC engine using methanol with a water injection system. Nowadays there are many types of fuel injection for example throttle body injection, common rail direct injection, multi-port injection and water injection in this project we are developing the water injection with methanol. There have been many investigations on methods of water- methanol injection and the effects on engine performance. By absorbing more heat energy, the in-cylinder temperatures are reduced, thus helping to suppress detonation. This study experimentally investigated the effect of water -methanol injection on the torque output, air intake temperature and exhaust gas temperatures in a naturally aspirated, spark ignition (SI) engine where water was injected at the intake port just before the throttle body. Furthermore, this study also investigated the effect of water- methanol injection on detonation. I have to analyze the performance of our water methanol injection so there was a major two test to conduct one is load test and another one is emission test. In addition to this the efficiency of the engine is found out by carrying out a load test and the emission test the results are compared with that of the normal petrol engines. This system can improve the efficiency of the engine and acting as the detonate cooling system. The total cost of the project is Rs.27500 including labor charges and transport charges and testing charges. Break-even is the point of zero loss or profit. At break-even point, the revenues of the business are equal its total costs and its contribution margin equals its total fixed costs, if I sell more than 270 units it's a profit, if it is below then its loss. In addition, payback period I could able to take back my investment within 12 months.

KEYWORDS: Water Methanol Injection System, Fuel Injector with Carburettor, Load TEST Setup, Fuel Measured Test Rig

Received: Feb 20, 2018; **Accepted:** Mar 06, 2018; **Published:** Mar 21, 2018; **Paper Id.:** IJMPERDAPR2018122

Original Article

INTRODUCTION

This project deals with the design and the fabrication of the water -methanol injection in IC engine. In an internal combustion (IC) engine, water- methanol injection, also known as Anti-Detonant Injection (ADI), is a process of cooling the combustion chamber of engines by adding water to the cylinder or incoming air-fuel mixture. ADI generally allows a greater compression ratio and reduces the problem of knock or detonation. With the introduction of intercoolers, the interest in water- methanol injection rapidly disappeared. However, water methanol injection is still used in aircraft engines today to increase thrust and cool the turbines. [1] The most common use of water- methanol injection is in vehicles with forced induction system, such as superchargers and turbochargers. These engines are tuned at higher compression ratios which increase chances of detonation and therefore benefit greatly from the cooling effects of vaporized water. The cooling effects of water- methanol injection allow the ignition timing of an engine to be advanced and hence run at higher engine speed while

extracting more air due to charge cooling effects. Aircraft during World War II used a 50-50 mixture of water and methanol that was often Sprayed into the supercharger of the aircraft engine to decrease detonation and allow the use of increased boost pressures[2]

Water provides a cooling effect due to higher density and high heat absorption properties compared to gasoline, whereas methanol fuel has a high octane fuel rating as well as the low latent heat of vaporization. Therefore, the alcohol and water mixture increases the resistance to knock, increase the octane rating of the fuel, reduce fuel consumption and increases engine power. High power output from engine results in a greater combustion pressure, which is often accompanied by higher temperatures in the cylinders. In addition to this, the efficiency of the engine is found out by carrying out a load test and the results are compared with that of the conventional engines. [3]

METHANOL INVESTIGATION

The Investigation was done by Harrington, J "Water Addition to methanol on Combustion, Emissions, Performance, and Knock, used a fuel flow meter to measure the fuel consumption, whereas this project will incorporate different aspects to measure the fuel flow in order to achieve a fuel mass flow rate. In the investigation, the engine is left to run for 10 minutes before any measurements were taken. This method will be incorporated in this project to ensure the engine operates in a steady state condition and essentially obtain accurate measurements. In the practical study, the effects of water -methanol injection is tested for a range of rpm and load while keeping the water methanol -injection rate constant at 1.8kgh-1 and 3kgh-. The experimental setup for the research investigation provides a good reference point for designing the project experimental setup. The main difference between the investigation and project is that the research was done by on the Sensitivity and Effect of Ignition Timing on the Performance of a Spark Ignition Engine: An Experimental and Modelling Study to use biodiesel fuel whereas this project will be using gasoline to conduct the experiments [4]

Components and Functions of Water- Methanol Injection System

IC engine	-	It burns the fuel inside the engine and transfer the power.
Fuel injector	-	It injects the fuel into the engine
Carburettor	-	It regulates the ratio of air and fuel and it controls the engine speed
Brake drum	-	It is used to transfer the load from engine to load gauge
Chain sprocket	-	It transfers the power from the engine shaft to a brake drum
Fuel tank with pump	-	It is used to store the fuel and pump is used to flow of the fuel

Working

The fuel-methanol mixture is stored in a tank for injection during the engine inlet process. The petrol 4 stroke engine has four processes like Suction, Compression, Power, and exhaust. During the suction process, the petrol is let inside the combustion chamber. During this process, the water -methanol is sprayed during the fuel petrol mixture. This is done in order to cool certain parts of the induction system where "hot points" could produce premature ignition. In engines, it is used to increase the thrust of the engine at low speeds and at pick up [5].

MATERIALS AND METHODS

This chapter explains the selection of the material of various components of the project. This chapter also explains various methodologies used for manufacturing the components of the project. The design of water- methanol injection engine involves the various components. The designing of various components first involves in a basic study. After the basics have been studied the materials of parts were selected. The components are designed such that it has good life should perform the desired optimal performance within the stated life period [6].

The fuel-methanol mixture is stored in a tank for injection during the engine inlet process. The petrol 4 stroke engine has four processes like Suction, Compression, Power and, exhaust. During the suction process, the petrol and is an inlet inside the combustion chamber. During this process, the water- methanol is sprayed during the fuel petrol mixture [7]

Load Test

A load test setup is made in order to find out the efficiency of the engine. The power from the engine is transferred to the brake drum with the help of the sprocket and the chain drive and a belt are wound around the brake drum. The belt can be loosened and tightened using the lead screw and the handle. The applied load can be visualized with the help of the gauges. Hence first the belt is fully loosened and the engine is made to run in this condition. That is the readings are taken for the no- load condition. The belt is tightened using the lead screw. Suitable loads are applied and the engine efficiency is calculated. The results of the load test are compared with that of the conventional engines and the efficiency is made clear and it is found that the ethanol engine is more efficient than the conventional petrol engines[8].

Smoke Test

The emission test in one of the key aspect of this testing project. The difference in the variation of the polluted gases evolved show the benefits of the project. Initially, the emission test is taken for the project without the injection of the water -methanol mixture where the amount of the gases such as NO_2, CO2 are noted down. Similarly, the same procedure is repeated for the IC engine with the addition of the water/methanol injection. Thus the emission test shows the variation in the amount of gases emitted from the exhaust before the addition of water/methanol and after the addition of the same which is to be discussed in the next chapter [9].

Testing of IC Engine Using Water Methanol Injection

The fabrication of prototype was done with good industrial practice. The fabrication of prototype was explained in the prototype was designed in such that it will have better performance while operation. The water-methanol mixture is stored in a tank for injection during the engine inlet process. [10] The four- stroke petrol engine has fourprocessess like Suction, Compression, Power, and exhaust. During the suction process, the petrol is inlet inside the combustion chamber. During this process,the water- methanol is sprayed during the fuel methanol-petrol mixture. This is done in order to cool certain parts of the induction system where "hot points" could produce premature ignition. In engines ,it is used to increase the thrust of the engine at low speeds and at pick up

In this section, the experimental setup and procedures of analysis are discussed. The design of the practical can be separated into two distinct sections; effect of water- methanol injection on engine torque output, intake air temperature,and exhaust gas temperatures, and also the effect of water- methanol injection on detonation or engine knock. These two sections will be combined in the project to effectively demonstrate the effect of water- methanol injection on the

performance of an IC engine. In this experiment, the test was conducted with the following parameters load, Speed and Time

In the present experiment, the parameters such as speed, time and load are varied throughout for all the experiments. The table comprises of a parameter of the water -methanol injection system. We have to mix the content of water and methanol in the mixture ratio, which has to be referred in the experimental procedure and pour into the tank. The micrometer circuit set up for the injection and the pump is set before the engine starts and initially, we have to check the engine is in neutral gear. A load test set up is made in order to find out the efficiency of the engine.

The power from the engine is transferred to the brake drum with the help of the sprocket and the chain drive and a belt are wound around the brake drum. The belt can be loosened and tightened using the lead screw and the handle. The applied load can be visualized with the help of the gauges. Hence first the belt is fully loosened and the engine is made to run in this condition. That is the readings are taken for the no -load condition. The speed can be measured through tachometer and the fuel consumption measured in the fuel consumption test rig. Repeat steps with a different mixture ratio of water- methanol and only petrol and the data were recorded.

RESULTS AND DISCUSSIONS

The Indicated horsepower and brake horsepower and mechanical efficiency of various load applying had been tabulated under varying fuel consumption and speed. The table comprises of testing of the project. The ratio of water and methanol are varied for the percentages 20%: 80%, 33%: 67%, 50%: 50%and the retardation test results are tabulated.

Table 1: Retardation Test of 20%: 80%

Ratio(W:M)	Replication (R)	Full Load(6kg)		3/4 Load(4.5kg)		1/2 Load(3kg)		1/4 Load(1.5kg)		No Load	
		F.C	Speed	F.C	Speed	F.C	Speed	F.C	Speed	F.C	Speed
20% : 80%	R1	30	1500	24	2000	18.5	2250	15	2500	10	3200
	R2	28	1550	25	2100	19	2180	16	2570	11	3180
	R3	31	1470	23	1980	17.6	2120	14	2469	9.8	3240
	AVG	30	1500	24	2000	19	2250	15	2500	10	3200

Table 2: Retardation Test of 33%: 67%

Ratio(W:M)	Replication (R)	Full Load(6kg)		3/4 Load(4.5kg)		1/2 Load(3kg)		1/4 Load(1.5kg)		No Load	
		F.C	Speed	F.C	Speed	F.C	Speed	F.C	Speed	F.C	Speed
33% : 67%	R1	29	1530	24	2075	16	2160	14	2540	11	3150
	R2	30	1540	25	2115	18.5	2240	16	2560	10	3220
	R3	28	1490	23	2130	17	2260	17	2510	11	3175
	AVG	29	1540	23	2115	18	2240	16	2510	11	3220

Table 3: Retardation Test of 50%: 50%

Ratio(W:M)	Replication (R)	Full Load(6kg)		3/4 Load(4.5kg)		1/2 Load(3kg)		1/4 Load(1.5kg)		No Load	
		F.C	Speed	F.C	Speed	F.C	Speed	F.C	Speed	F.C	Speed
50% : 50%	R1	30	1535	25	2060	18	2160	15	2430	10	3230
	R2	29	1545	23	2140	18.5	2230	16	2550	11	3120
	R3	28	1485	21	2130	17	2210	17	2460	11	3210
	AVG	29	1540	23	2125	18.5	2000	16	2540	11	3235

Table 4: Overall Test Performance

S.No	Engine Speed(rpm)	Indicated Horse Power(Hp)	Brake Horse Power(Hp)	Frictional Horse Power(Hp)	Mechanical Efficiency (%)	Sfc (Kg/Hr)
1	1000	1.3	1.1	0.2	84	0.181
2	1500	1.99	1.64	0.35	82	0.121
3	2000	2.91	2.38	0.53	81	0.192
4	2500	3.92	3.27	0.65	83	0.245
5	3000	4.59	3.78	0.81	82	0.3
6	3500	5.53	4.5	1.03	81	0.44

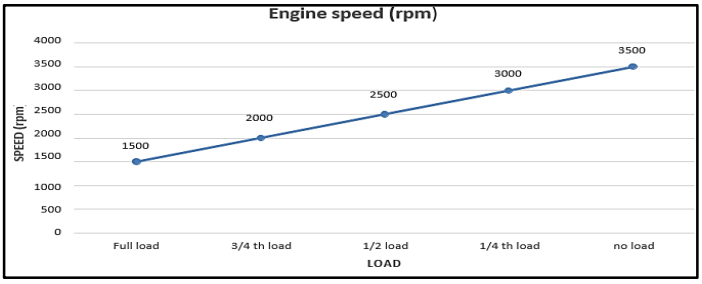

Figure 1: Engine Speed Vs Load

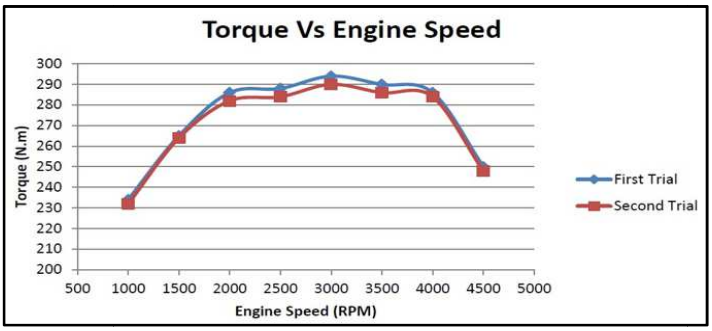

Figure 2: Engine Speed Vs Torque

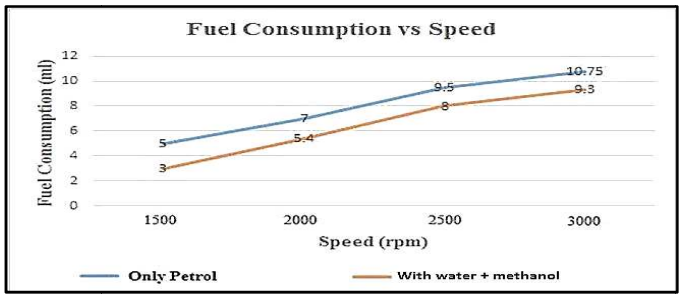

Figure 3: Load Vs FHP and Fuel Consumption Vs Speed

The graph shows that the amount of fuel consumed when the engine works without water methanol injection is comparatively more when compared to that of the engine that is working with water -methanol injection. When comparing all the four graphs it is practically proven that the amount of fuel consumed when the engine works under the addition of water -methanol injection is comparatively less when compared to that of the engine that works without the influence of the water -methanol injection.

CONCLUSIONS

This model could be applied in the field of industries for efficient as well as effective testing of material properties. Though the manufacturing cost is very low, as well as the maintenances too. It reduces the late elimination and associated cost. Finally the IC engine which is tested with the implementation of water- methanol injection is been completed and is showing the positive result, such as improvement in efficiency of the engine and the reduction of smoke level of the engine which works with the injection mixture when compared to the IC engine which is running only with the help of the petrol.

REFERENCES

1. *Chiu, R.P and Hong, L.H, 1946, "The Effects of Methanol Injection on Emission and Performance in a Carbureted SI Engine," SAE Technical Paper 790954.*
2. *Harrington, J., 1928, "Water Addition to methanol on Combustion, Emissions, Performance, and Knock," SAE Technical Paper 820314, doi:10.4271/820314.*
3. *Hayashi, S., Kubota, Y., Sawa, N and Kajitani, S., 1991, "Influence of Operating Conditions on Output, Exhaust Emission and Combustion Variation of Low Compression Ratio Methanol Injection Engines," SAE Technical Paper 910866.*
4. *Karthe. M, Prasanna. S.C "Investigations on the emission characteristics of diesel engine blende with isopropyl alcohol" Pakistan Journal of Biotechnology Vol. 14 special issue Pp. 160 - 163 (2017)*
5. *Kakaee, A.H., Shojaeefard, M.H., and Zareei, J., 2011, "Sensitivity and Effect of Ignition Timing on the Performance of a Spark Ignition Engine: An Experimental and Modeling Study", vol. 2011, no. 7, pp. 1-8, Journal of Combustion, DOI: 10.1155/2011/678779.*
6. *Liao, S.Y, Jiang, D.M, Cheng, Q., Huang, Z.H, and Wei, Q., (2005), "Investigation of the chain sprocket characteristics.", vol. 19, pp. 813-819.*
7. *Rowe, M.R, and Ladd, J.I, 19, :Water Injection for Aircraft Engines," SAE Technical Paper 460192.*
8. *Vignesh.C ,.Prasanna "Effect of constructional change in I.C engine piston by partially ceramic coating" Pakistan Journal of Biotechnology Vol. 14 special issue Pp. 116- 119 (2017)*
9. *Subramaniam, V., Mallikarjuna, J.M and Ramesh, A., 2007, "Effect of Water Injection and Spark Timing on the Nitric Oxide Emission and Combustion Parameters of a Hydrogen Fuelled Spark Ignition Engine", vol. 32, pp. 1159-1173, via Science Direct.*
10. *Tesla, B., Mishra, R., Gu, F. and Ball, A.D, 2012, "Water Injection Effects on the Performance and Emission Characteristics of a CI Engine Operating with Biodiesel", vol. 37, pp. 333-344, via Science Direct journal.*